

Maxwell and to adopt this definition at the outset, for it is from the value of the energy that the coefficient is always calculated.

The methods of vector analysis are so useful in electromagnetic theory and present so little difficulty that the reader naturally expects to find them used in a book which is intended to present a "thoroughly modern introduction" to that theory. The author makes a slight use of this analysis in his later chapters, but in the case of vector products adopts a hybrid notation. In the true vector analysis, as used by Heaviside, if the vector product of the two vectors **A** and **B**, which make an angle θ with each other, be the vector **C**, the result is denoted by

$$\mathbf{C} = \mathbf{VAB},$$

while the magnitude (C) of the product is given by

$$C = AB \sin \theta.$$

In the author's notation the relation between **C**, **A** and **B** is expressed by

$$\mathbf{C} = \mathbf{VAB} \sin \theta,$$

the letter **V** serving to indicate that **C** is at right angles to the plane of **A** and **B**. It is difficult to see that this hybrid notation has any advantage over Heaviside's.

A few misprints have been noticed in a list sent out by the author; only a few others have been detected.

The reader has probably already gathered from this review that the treatise can hardly be described as that "good text-book" for which the student searches. Yet it is undoubtedly a useful book, and with a little modification and revision would be one of the best books of its class. The student who is fortunate enough to have it at hand will often turn to it with profit.

G. F. C. SEARLE.

ASTRONOMICAL LECTURES AT CHICAGO.

Astronomical Discovery. By Herbert Hall Turner, D.Sc., F.R.S., Savilian Professor of Astronomy in the University of Oxford. Pp. xi+225. With plates. (London: Edward Arnold, 1904.) Price 10s. 6d. net.

THE object of this book and the reason for its appearance are explained in a short preface. The purpose is "to illustrate by the study of a few examples, chosen almost at random, the variety in character of astronomical discoveries." The words "almost at random" seem a little out of place, for we learn that the book comprises the matter that was originally delivered in a series of lectures to the University students of Chicago, at the hospitable invitation of President Harper. The expression is probably not to be taken too seriously. It is not likely that a distinguished astronomer, enjoying what may be regarded as a cathedral position, would be careless in the preparation of his material. He would be anxious to give his best, both for the credit of English astronomy and for his own reputation. There is ample internal evidence, not only that the lectures were carefully prepared, but also of judicious selection.

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The subjects chosen are about equally distributed between those that are made at the telescope and those that have resulted from the discussion of the observations so made. This will be seen from a list of the several chapters or lectures—(1) Uranus and Eros, (2) discovery of Neptune, (3) Bradley's discoveries of aberration and nutation, (4) accidental discoveries, (5) the sun-spot period, and (6) the variation of latitude. Some subjects which might have been expected to find a place, such as the discoveries resulting from the application of the spectroscope, have been omitted, but the list is sufficiently varied, and we gratefully acknowledge having received a considerable amount of pleasure from reading the well-known and familiar tales, treated, as they are, with the brightness and acuteness characteristic of the author.

The choice of the discovery of Uranus permits a well-deserved tribute to be paid to the memory of the elder Herschel for the keenness, assiduity and patience which mark the work of that astronomer; while the mention of Eros allows something to be said of the problem of the sun's distance and of the history of those times when the discovery of a small planet added something to the reputation of the lucky discoverer. The Savilian professor has some amusing remarks on the subject of naming the host of small planets that diligence has added to our catalogues. He quotes the case of Victoria as giving rise to an outcry by foreign astronomers, who objected to the name of a reigning sovereign being found in the list. But the real struggle of the purists was, we believe, over the christening of Fortuna; which Airy happily settled in favour of the discoverer's choice, by aptly quoting the well known lines of Juvenal:—

" Nullum numen habes si sit prudentia
Sed nos te facimus fortuna deam, cæloque locamus."

The second chapter or lecture is probably the least satisfactory in the book. The tale might have been told without parading the old scandal of sixty years ago to such wearisome length. Controversy seems out of place in lectures of this character. Prof. Turner in reopening the old sore has apparently two objects, the one, the whitewashing of Airy, and the other, the besmirching of Challis' reputation. Very hard things are said of the latter to which we do not wish to give further currency by repeating, but on the subject of Challis' lectures we doubt whether the words given in Airy's "Life" will bear the construction put upon them by Prof. Turner. There is no evidence to show, or at least the author has not produced it, that Airy's opinion was different in 1844 from what it was in 1834, when he wrote to the Rev. T. J. Hussey: "I am sure it could not be done (predict the place of the disturbing planet) till the nature of the irregularity was well determined from several successive revolutions" (of Uranus), p. 43. Airy, it may be suggested, did not believe the problem soluble until he received Le Verrier's memoir in 1846.

The account of Bradley's discoveries is excellent, and the feature in it which will be especially valued is the brief history given of the Rev. James Pound,

Bradley's maternal uncle. The reputation of Pound has been overshadowed by that of his more brilliant, but perhaps less versatile, nephew, and it is most desirable to give the uncle his proper position. The whole chapter constitutes a most delightful piece of biography.

The accidental discovery of a "new star" does not differ materially from that of a planet, and the author admits that this fourth chapter might very well have been the first of the series, but we agree with him that it is not a matter upon which to lay any particular stress. The particular discovery is only a peg on which to hang the remarks that the author wishes to make on certain subjects. In this case the discovery of the "new star" in Gemini, at Oxford, by means of photography, serves to introduce an account of the International Chart of the Heavens, and some remarks connected with the behaviour of Nova Persei. This chapter presents a careful examination of the facts and suggestions that have been brought to light by observation. The history of Schwabe and his work on sun-spots do not call for any particular remark. The chapter is not long, and it covers the ground very satisfactorily. In the last lecture, Prof. Turner gives an account of the variation of latitude, wherein he is seen quite at his best. The subject is not so hackneyed as some of the other selections, but to speak to Americans of the work accomplished by Mr. Chandler was, no doubt, inspiring, and the successive steps by which Mr. Chandler established his case are described with clear, logical sequence. Usually the author ends his lecture by pointing out what particular lessons are to be drawn from the discovery under examination, and they generally amount to this, that there is no line of research, however apparently unimportant or monotonous, which can be safely neglected. Some inquiries seem to offer a more immediate prospect of success, such as the establishment of observatories in the Southern Hemisphere, to make accurate observations on the motion of the Pole; but at the same time unexpected discoveries may lie in a direction precisely opposite to that indicated by the most educated opinion at present available. The conclusion may be obvious, but the remark is not unnecessary. To be led too strictly by authority is unwise, to neglect the teachings of experience is a crime.

W. E. P.

ZOOLOGICAL RESULTS.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, collected during the Years 1895, 1896, and 1897, by Arthur Willey, D.Sc.Lond. Parts i.-vi. Pp. vi+830; illustrated. (Cambridge: University Press.)

THIS splendid series of "zoological results" should have been recognised at an earlier date in our columns, but the six volumes have appeared through a lustrum of five years, and the fine series of memoirs has mounted up to a total which baffles reviewing. As Balfour student of the University of Cambridge, Arthur Willey went in 1894 to the Pacific

in search of the eggs of the pearly nautilus. He found these, but so much more of great interest, e.g. as to *Peripatus*, *Amphioxus*, *Balanoglossus*, *Ctenoplana*, that his tenure of the Balfour scholarship was on two successive occasions judiciously extended for a year beyond the allotted triennium. In his arduous but well rewarded explorations, Dr. Willey was aided by the Government Grant Committee of the Royal Society, who may congratulate themselves on the fact that the money at their disposal was never better spent than on this enterprise. It has seldom been the happy fortune of a single zoologist to bring together in a short span such rich material, including some of the most interesting zoological types.

In part i. Dr. Willey describes the structure and development of *Peripatus novae-britanniae*, n.sp., and in so doing throws some fresh light on the heterogeneity of the class *Onychophora*, which this "delightful creature" represents. Dr. Paul Mayer describes a new caprellid; Mr. G. A. Boulenger discusses a very rare sea-snake (*Aipysurus annulatus*) from the South Pacific; Mr. R. I. Pocock reports on the centipedes, millipedes, scorpions, *Pedipalpi*, and spiders; and Dr. Sharp gives an account of the phasmids, with notes on their remarkable eggs.

In part ii. Prof. Hickson reports on *Millepora*, showing that the single species (*M. alicornis*) illustrates that great variability in the form of growth which is a characteristic feature of the genus. Prof. Jeffrey Bell discusses the echinoderms (other than holothurians, which are dealt with separately by Mr. F. P. Bedford). Mr. Arthur E. Shipley reports on the sipuloids, Mr. J. Stanley Gardiner on the solitary corals and on the post-embryonic development of *Cycloseris*, Mr. Beddard on the earthworms, and Miss Isa L. Hiles on the Gorgonacea, which includes some interesting new species.

In part iii. Dr. Gadow has an interesting essay on orthogenetic variation in the shells of *Chelonia*, that is to say, cases in which the variations from the normal type seem to lie in the direct line of descent; Dr. Willey describes three new species of *Enteropneusta*, and develops several theories, e.g. that the gill-slits arose originally as perforations in the inter-annular grooves for the aeration of the gonads which occupied the dividing ranges; and Mr. A. E. Shipley reports on the echiurids, making a welcome attempt to revise the group and to determine its geographical range.

In part iv. Mr. Stanley Gardiner describes the structure of a supposed new species of *Cenopsammia* from Lifu, and comes *inter alia* to the striking conclusion that the so-called endoderm in Anthozoa, giving rise to the muscular bands and generative organs, and performing also the excretory functions, is homologous with the mesoderm of *Triploblastica*. In terms of the layer theory, of whatever value it may be, the actinozoan polyp must be regarded as a triploblastic form. Dr. Sharp reports on insects from New Britain, Mr. L. A. Borradaile on *Stomatopoda* and *Macrura* from the South Seas, Mr. Walter E. Collinge on the slugs, Mr. E. G. Philpott on the *Polyzoa*, Miss Laura Roscoe Thornely on the hydroid zoophytes, and Mr. J. J. Lister describes a remarkable type of a new family